Kathmandu University
Department of Electrical and Electronics Engineering
ANALOG ELECTRONICS LABORATORY EXPERIMENTS

EXPERIMENT 10: Differential Amplifier

Objective: To understand the DC and AC operation of a differential amplifier

Software:
Multisim 8

Theory:
Differential Amplifier amplifies the difference signal. Due to low common mode gain and high differential gain it can reject the noise which is common to both the input sensors. Ideally, differential amplifier has infinite common mode rejection ability (High CMRR). For the structure as shown in fig 1, single ended common mode gain and single ended differential gain is given by (1).

$$A_C = -\frac{R_C}{2R_E},\ A_d = -\frac{R_C}{2r_e} \qquad \text{CMRR} = 20\log\left(\frac{\text{A}_\text{d}}{\text{A}_\text{C}}\right)\text{dB} \tag{1}$$

The transfer characteristic of the differential amplifier is given by (2).

$$V_O = -I_O R_C \left(\frac{e^{\frac{v_{id}}{V_T}} - 1}{e^{\frac{v_{id}}{V_T}} + 1}\right) \tag{2}$$

The complete transfer function of a differential amplifier is given by a hyperbolic tan function.

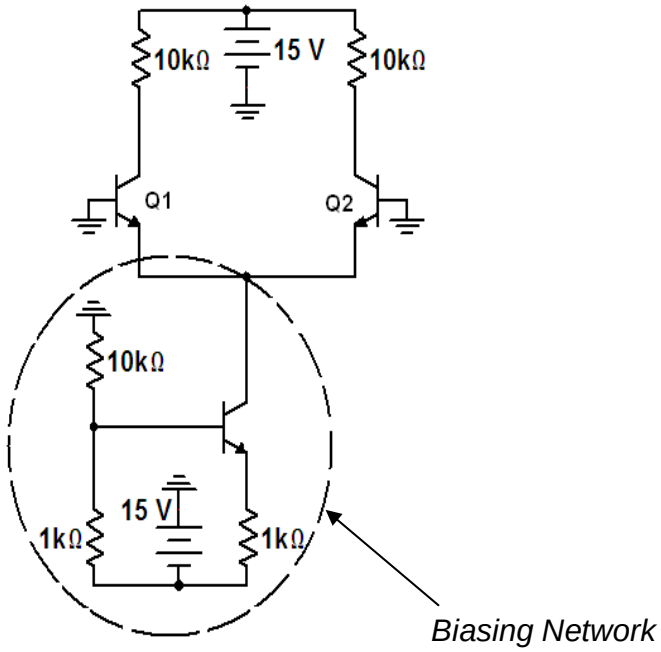

Fig: 1

Procedure

DC Analysis

1. Connect the circuit as shown in fig 1.
2. Find V_{EQ} and I_{EQ} of the biasing network.
3. Find V_{BEQ1} and V_{BEQ2}.
4. Find I_{EQ1} and I_{EQ2}.
5. Find V_{CQ1} and V_{CQ2}.
6. Theoretically calculate r_e.

AC Analysis

1. Connect 10mV sine @ 1 kHz to the base of Q1 and connect base of Q2 at the ground potential.
2. Connect CH1 of oscilloscope to the input and CH2 across collector of Q1.*Use AC coupling*
3. Sketch the output and find the gain.
4. Connect CH2 across collector of Q2.
5. Sketch the output and find the gain.
6. Compare the sketch of (3) and (5).
7. Connect 10mV sine @ 1 kHz to the base of Q2 and connect base of Q1 at the ground potential.
8. Repeat procedure (2) to (6).

Tan Hyperbolic Distortion

1. Connect 10mV sine @ 1 kHz to the base of Q1 and connect base of Q2 at the ground potential.
2. Connect CH1 of oscilloscope to the input and CH2 across collector of Q1.*Use AC coupling*
3. Change the display of oscilloscope to XY mode.
4. Change the amplitude of input signal by 20 mV and see the tan hyperbolic distortion on XY mode and in YT mode also.
5. Find the saturation limit. Change the collector load resistors to 5K and again note the saturation limit.

Large Signal Distortion

1. Change input voltage amplitude to 10 V and then 15 V. Note the amplitude in both cases in XY mode as well as in YT mode.

CMRR

1. Connect 10mV sine @ 1 kHz to the base of Q1 and connect base of Q2 at the base of Q1.
2. Sketch the output waveform.
3. Calculate the CMRR.

Frequency Response

1. Use AC analysis to find the frequency response.
2. Find the gain for 1 Hz.